



**PROGRAM IN CHEMICAL BIOLOGY**

UNIVERSITY OF MICHIGAN

# PhD Student Handbook

Fall 2017 Edition

[www.chembio.umich.edu](http://www.chembio.umich.edu)

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## **ABOUT THE PROGRAM**

One of the most exciting developments of modern biology is our growing ability to study the molecular details of biological macromolecules using techniques developed by chemists, biochemists and structural biologists. These molecular details provide fundamental insights into the functional properties of biological molecules and suggest routes by which they can be manipulated. The discipline of chemical biology is premised on the view that understanding the molecular mechanisms of biological processes provides an opportunity to manipulate them in a defined and predictable fashion.

At virtually every major university in the United States, research in chemical biology is dispersed among several departments (e.g., biology, chemistry and biochemistry) and schools (e.g., literature & science colleges and medical schools). This dispersion often results in graduate training that is fragmented or inadequate. In addition, no single department or graduate program by itself has large numbers of faculty working in chemical biology. Therefore, choices for thesis research in any given department or program can be limited.

The University of Michigan is a recognized leader in the application of chemical approaches to biological problems and has been for many years. To better serve the needs of today's students, the Chemical Biology Program was developed. This program offers didactic and research training leading to the Doctor of Philosophy degree in Chemical Biology. A unique feature of this program is the offering of high-level, in-depth training in core areas of chemistry and biology, followed by specialized coursework based on students' interests. Importantly, the Chemical Biology Interdisciplinary Doctoral Program coalesces faculty in chemical biology from a number of departments into a single training faculty. This 'virtual department' provides students with over 40 different faculty choices for dissertation research. Completion of the program will equip students with the wide-ranging knowledge and skills necessary to successfully compete for top positions in academic research, teaching, industry or administration.

## **DOCTORAL DEGREE PROGRAM**

This section provides information on the requirements for the degree of Doctor of Philosophy in Chemical Biology. The requirements stated here include those set by the Program and those set by the Rackham School of Graduate Studies. Students are also encouraged to consult the Rackham Graduate Student Handbook (<http://www.rackham.umich.edu/current-students/policies/academic-policies>).

Program requirements for the Ph.D. degree are administered by the Operating Committee, which consists of the Program Director, Associate Director and several Program faculty. The Program Director, in consultation with this Committee, has the authority to set and interpret rules and requirements and, when circumstances warrant, grant exceptions upon formal appeal. Upon entry, each student will discuss the following topics with a member of the Operating Committee: his/her background, objectives and any questions related to progress to the Ph.D. degree. The Operating Committee provides advice to the student until a Research Advisor has been formally selected, at which time the Research Advisor will undertake these advisory duties. However, throughout the tenure of the Program, students are encouraged and welcomed to consult with the Program Director, Operating Committee and Dissertation Committee for additional advice and guidance. If questions, concerns or conflict arise at any point in the Program prior to selection of a Research Advisor, students should contact the Program Director or their designate. After selection of a mentor, students should work closely with their Research Advisor to resolve any

questions or concerns. If an issue cannot be addressed at this level, students and faculty should contact the Program Director or their designate.

Course elections for each term must be approved either by the Operating Committee or the Research Advisor. Each student's status is reviewed by the Operating Committee after each term and an appropriate report is provided to the student when needed. NOTE: Failure to follow the approved registration can jeopardize a student's standing in the Ph.D. program, which could result in suspension of stipend and benefits. Students should not make unapproved changes to their schedules.

### **Academic Schedule – <http://www.ro.umich.edu/calendar/>**

The academic year at the University of Michigan consists of three full terms: Fall, Winter and Spring/Summer. The Fall term begins in September and ends in December; the Winter term runs from January through April. Each Fall and Winter semester has a mid-term break in which classes do not meet and a final exam period at the end of the term. The Spring/Summer term spans May through August. Two short terms, Spring and Summer, run concurrently with the Spring/Summer term. Spring classes meet May through June and Summer term courses meet July through August. Most didactic courses of interest to graduate students are offered only in the Fall and Winter terms. Though students are typically not registered in the Spring/Summer term unless they are completing their dissertation, students are expected to be conducting research and completing the plan of study outlined by their Research Advisor.

Class periods begin ten minutes after the hour (or half-hour), although classes are listed as beginning on the hour or half-hour. Note: The words "semester" and "term" possess identical meanings at UM and are used interchangeably.

### **Requirements for the Ph.D. Degree**

The degree Doctor of Philosophy is the highest degree conferred by the University of Michigan. It is a research degree. It is never conferred solely as a result of study, no matter how faithful, extending over any prescribed time period or for any amount of course work or research accumulated. The degree represents more than merely the sum of semesters in residence and of credits for courses taken. The length of residence and the plan of study are of secondary importance. The degree is granted solely upon evidence of general proficiency and of distinctive attainment in the special field chosen by the candidate. The degree is granted particularly upon a recognized ability for independent and insightful investigation as demonstrated in a thesis based upon original research combined with creative scholarship and presented with a high degree of literary skill.

### **Program Requirements**

Program requirements are directed primarily towards giving students practice and skills in research, discovery, problem solving and creative learning, particularly in their area of interest. The requirements governing examinations and basic courses are designed to test and solidify the fundamental background of the student in the main branches of chemical biology while still encouraging an early start in research.

A student is expected to remain in good standing during his/her term of study by complying with the rules, regulations, and requirements set forth by the Rackham Graduate School, the Chemical Biology Program and completing the duties of his/her Graduate Student Research Assistantship (GSRA) appointment or Graduate Student Instructorship (GSI) appointment if appropriate.

## **Graduate School Requirements**

The basic requirements for the degree of Doctor of Philosophy set by the Graduate School and the Program include:

1. Bachelor's degree or equivalent.
2. A "B" (3.0 on a 4.0 scale) average for all courses in the graduate student's record.
3. At least 18 credit hours of graded graduate coursework registered as a Rackham student while in residence on the Ann Arbor campus.
4. Appointment of a Dissertation Committee to supervise the student's program and progress in research.
5. Recommendation by the Program for admission to candidacy (Candidacy Exam).
6. Approval of the written dissertation by the Dissertation Committee and the Graduate Dean and a final oral examination by the Committee (Dissertation Defense).

## **Credits and Rackham Requirements**

Students enrolled in the full-time Chemical Biology course of study must be registered for each Fall and Winter term until final completion of all degree requirements unless they have received an authorized leave of absence or approved extramural study. Additional information on leave of absence and extramural study may be obtained from the Program Office or from Rackham.

A student is considered full-time with registration of eight credit hours per term. Pre-candidate students may register for one to eight credit hours of CHEMBIO 990 (pre-candidate research) per term as approved by the advisor in addition to any electives.

The current Rackham requirement for candidacy provides for a minimum of 18 credit hours of graded (including the grade of S – Satisfactory) graduate coursework registered as a Rackham student while in residence on the Ann Arbor campus. All required Chemical Biology graduate courses as well as electives may be used to fulfill this requirement. CHEMBIO 990 (pre-candidate research) as well as courses taken as visit (audit) do not meet this requirement.

After admission to candidacy, students register for eight units of CHEMBIO 995 (dissertation research) for every term including the defense term. After passing candidacy, a candidate may take either one course per term, or to take more than one course for a total of no more than 4 credits, in addition to CHEMBIO 995 without an additional fee with the approval of the research advisor. Additionally, a candidate who does not take any courses during a term may either register for courses totaling up to 8 credits in the following term, or take no more than two courses that total more than 8 credits. "Unused" credits not taken do not roll over beyond the term immediately following it.

## **Course Requirements**

Program requirements for coursework fall into two categories: (a) those specified by the Program and applying generally to all students, and (b) those specified by the student's academic advisor.

The Operating Committee and the student's Dissertation Committee both are charged with the responsibility to see that the individual student has a program of course work that is both broadly supportive of his/her specialized field of study and also indicative of the breadth and range of interest.

One of the requirements of the Program is for a student to be “in good standing,” which requires the student to maintain a grade point average (GPA) of 3.0 or better, on a 4.0 scale. This average must be achieved by the end of the second term. Research and seminar courses are not included in calculation of the GPA.

An “I” (incomplete) grade may be assigned to a student only if the unfinished part of the student’s work is small, the work is unfinished for reasons acceptable to the instructor, and the student’s standing in the course is a “B” grade or higher. Incomplete grades can be changed to letter grades only if the incomplete work is made up by the end of the fourth full term beyond the term for which the “I” was assigned. The grade of “I” is permanently retained on the student’s record next to the actual grade. For example, if a student submits the completed work after receiving an “I” and has earned a B+ for the course, the grade will appear on the transcript as “IB+.” “I” grades are not accepted for thesis research courses (CHEMBIO 990 and 995).

The Program is concerned that the student has an adequate undergraduate background in chemistry, biology and mathematics and that the Program’s core courses adequately prepare students to branch into more specialized fields in chemical biology and to begin independent research. During Year One, students are required to complete four core courses in Chemical Biology: CHEMBIO 501, 601, 502 and 602. Also in Year One, students are required to complete PIBS 503 (research responsibility and ethics) and two terms of CHEMBIO 599 (Chemical Biology Research Rotation). In Year Two, students are required to present their research, usually at the annual Program in Chemical Biology Fall Retreat prior to the beginning of the Fall Term. In addition to the core courses, four other graduate level courses (minimum of 2 credits) are required. Students are expected to take a suite of electives that cover the breadth of Chemical Biology. Students entering with relevant previous graduate credit from other universities may be excused from some of the preceding course requirements by petitioning the Program Director and Operating Committee.

### **Research Rotations**

In order to help students choose a Rotation Advisor and research group, all new students are required to register for laboratory rotations in the Fall and Winter terms of Year One (CHEMBIO 599). Research rotations acquaint students with the research efforts of the faculty whose research matches their interest. First year students are also required to attend the Poster Session at the Program in Chemical Biology Fall Retreat which is typically held the week before Fall classes. This session provides students with the opportunity to meet faculty and their research groups, ask questions, and select a lab in which to rotate for the Fall term. The Program Office provides the incoming students with rotation project descriptions and faculty contact information for the students to prepare before the Fall Retreat.

In many cases, students will elect a Research Advisor from one of the labs in which they have rotated; however, there is no compulsion for the students to join the research groups in which they rotate. Fall laboratory rotation projects must be selected by the second week of classes; Winter lab rotation projects are selected in the first week of December. Faculty are not permitted to make rotation commitments to students prior to the Fall Retreat. For the Winter term, that date is the 4<sup>th</sup> week of November.

In general, 20 hours per week of time spent conducting research in the lab is considered the minimum requirement, although each lab will differ. Additionally, students are encouraged to

spend as much of their study time in the laboratory as possible, as this provides students with the greatest exposure to the laboratory culture.

Once a research rotation is complete, students are required to prepare a one-page report that consists of the following sections: introduction, results, discussion, conclusion and references (references are not to be included in the one-page requirement). This report must be prepared independently by the student and submitted to the Program Office by the last day of classes.

### **Choosing a Research Advisor**

Choosing a Research Advisor occurs at the end of the second term of enrollment. The formal steps preceding the choice include:

1. Completion of the research rotation course (CHEMBIO 599) in two separate labs over the Fall and Winter terms.
2. Discussion of the student's research focus and interests with the academic advisor at the time of the first term counseling.
3. Attendance at the Program in Chemical Biology Fall Retreat Poster Session (required).
4. Discussion of any questions or concerns with the Operating Committee advisor, the Program Director or the Associate Director.

The student and the Research Advisor are jointly responsible for following the Program and Graduate School requirements for the Ph.D. degree. The Advisor's responsibilities begin at the time of his/her agreement to accept the student into his/her group. In addition to supervising the research, the Research Advisor is expected to advise the student on course elections, examinations, independent study pertinent to his/her general development as a scientist and any other matters affecting his/her general progress toward a degree. Faculty are not permitted to make Research Advisor commitments to students prior to the first Monday in April each year.

Students are expected to find a Research Advisor by the beginning of the Spring term of their first year. Under special circumstances the student may choose to rotate during the spring term with the expectation that they will find a Research Advisor by the beginning of the Summer term.

### **Formation and Function of the Dissertation Committee**

A Dissertation Committee should be assembled by each graduate student in consultation with his/her Research Advisor before beginning Year Two in the Program. The composition of the Committee should be reported to the Program Office no later than the last week in August of Year One so that it may be recorded with the Graduate School. The Research Advisor serves as chair of the Committee and shares the responsibility of guiding the student toward the doctoral degree with the other members. All Dissertation Committees must consist of at least four members of the graduate faculty including the Research Advisor; at least two of the four members being from the Program in Chemical Biology.

The Program requires that a student meet with their Dissertation Committee before being admitted to candidacy. The Dissertation Committee may consult with the student about concerns of his/her development as indicated by his/her course work, seminar participation and performance during examinations and in conducting research.

After being admitted to candidacy, the Dissertation Committee will meet at least once per year in order to assess the progress being made towards completion of the thesis. It is the responsibility of the student to arrange this meeting. Meeting dates should be forwarded to the Program Office so they may be recorded in the student's permanent file.

### **Advancing to Candidacy**

Admission to candidacy marks the transition from a largely classroom-based experience to one that is focused on independent research. This milestone should occur as soon as possible and must be completed before Fall term in Year Three in order to remain in good academic standing. Early candidacy is advantageous to be eligible for reduced tuition (in general, candidate tuition is roughly 1/3 of the cost of pre-candidate tuition) and to be eligible for certain grants and fellowships administered by the Graduate School and external organizations. Before admission to candidacy may be recommended, a student must meet the following requirements:

- Passing of course requirements as specified by the Program and by the Research Advisor.
- Achievement of a 3.0 or better grade point average (on a 4.0 scale).
- Choice of a Research Advisor.
- Appointment of a Dissertation Committee.
- Earning at least 18 credit hours.
- Passing the oral examination.
- Be formally recommended for candidacy by the Dissertation Committee.

### **Early Candidacy**

Students interested in advancing to candidacy before the winter term of their second year will need to discuss the option with their advisor as soon as they join their advisor's research group. After obtaining the support of their advisor the student should notify the program of their intent for early candidacy before August 1st of their first year. The program will ensure that all Rackham requirements are met before the oral examination and the formal recommendation for candidacy.

### **The Candidacy Examination**

Each Chemical Biology student is subject to an oral candidacy examination by his/her Dissertation Committee, excluding the advisor and any co-advisors. This examination is held in Year Two and is to be completed before the Rackham candidacy deadline. It is designed to evaluate a student's preparedness for dissertation studies by examining the student's knowledge in the fundamental scientific disciplines underlying the proposed Ph.D. research. Although many aspects of the exam may focus on the research proposal, this is not intended to be a dissertation committee meeting.

The Dissertation Committee will elect a Chair (other than the Research Advisor) before the examination meeting and that Chair will be responsible for the conduct of the exam and to consult with the student's Research Advisor prior to the exam if needed. The Research Advisor is not a member of the examining committee and does not attend the oral examination.

In preparation for the exam, the student must submit a written proposal to each member of his/her Dissertation Committee at least two weeks before the exam. This is a hard deadline. The proposal must be sufficiently detailed so that the nature of the research problem and the direction of the effort are defined and characterized; however, the proposal is not to exceed ten double-

spaced typed pages (not including references) and must be written in an NIH-derived format. The proposal should contain:

- a) Background
- b) Specific Project Goals
- c) Research Plan
- d) Preliminary Data
- e) Literature References

The purpose of the Candidacy Exam is to determine if the student is ready to lead their thesis project and if there are areas of knowledge or experimental design that need strengthening in order for the student to succeed. Towards that end, at the Exam the student presents a summary of their research project, no more than 15 slides. This is best accomplished by presenting brief background material that illustrates why the object of study is important and places the specific work by the candidate in context followed by the particular project goals; typically this is presented in Specific Aim format similar to an NIH proposal. Results generated thus far should be presented (and are expected) followed by specific future experimental plans for each project goal. Students can expect questions on the background material in addition to specific questions about the choice of experiments, strategies for data analysis and alternative plans if things do not work as outlined. This Exam should not last longer than 2 hours at which time the committee will provide specific feedback to the student. There are several possible outcomes of the Exam: Pass, Pass with additional requirements, Fail. The Pass with additional requirements typically occurs if it is noted that a student needs to shore up knowledge in a specific area or if a specific aspect of the project needs to be more clearly defined. In such cases, the Committee will ask the student to take a course, identify a collaborator and/or re-write an aspect of their candidacy document. A Failing grade reflects more significant issues and the committee will provide specific recommendations on addressing the concerns. Students who do not pass their exam at the initial taking are able to re-take the exam within a 3-6 month time frame.

### **Annual Dissertation Meeting**

Students in their third and fourth years of study are required to have a meeting with their dissertation committee before the end of the Spring term. This is a chance for the committee to review and discuss data and to monitor progress toward the degree. A student must submit an Annual Dissertation Meeting form to the Program Office signed by all the committee members before the start of the Summer term. This record of academic progress becomes a part of the student's academic record.

Students in their fourth year of study are required to submit to their dissertation committee a draft timeline that outlines the final experiments, analysis, and writing schedule. This timeline is also submitted to the Program Office.

Students who are in their fifth year of study should be scheduling and holding meetings with their dissertation committee in preparation for their dissertation defense. For those students in their fifth year a meeting with the dissertation committee must occur by the first Monday in April.

### **The Dissertation**

The regulations governing the preparation of the dissertation are provided in the Handbook for Doctoral Candidates (<http://www.rackham.umich.edu/doctoral-degree-resources>), which is

distributed by the Graduate School. Candidates begin drafting the dissertation after the Committee deems the student adequately prepared.

All additional steps and requirements before, during, and after the dissertation defense can be found within the Rackham Doctoral Degree Resources: <http://www.rackham.umich.edu/doctoral-degree-resources>.

### **Dissertation Defense**

The subject matter of the dissertation is to be presented at a public Program seminar (Thesis Colloquium) in the last term of the student's residence. This is followed by a private session with the Dissertation Committee. The student is responsible for arranging his/her dissertation defense in consultation with his/her Dissertation Committee. Oral defenses must be public. OARD will publicize the date, time, and location of the defense provided by the candidate.

The Final Oral Examination Report should be submitted to Rackham within 48 hours of the exam, but no later than the deadline for the final term of enrollment. The student should confirm with the chair of the Dissertation Committee that the report has been submitted. Any disagreement over the acceptability of a dissertation will be resolved by the Dean of the Graduate School, who will act as final arbiter in consultation with the Dissertation Committee members. The Certificate of Dissertation Committee Approval must be submitted no later than the deadline for the final term of enrollment. As well as completing the pre-defense meeting the candidate must also register with Rackham OARD for a post-defense meeting and complete the final paperwork also before the final deadline for the term. A candidate who fails to submit these materials by the deadline will be required to register for another term and incur tuition charges.

Additional information is available in the Rackham Dissertation Handbook, including defense formatting, what to do if committee members are unable to attend, final submission, and so on: <http://www.rackham.umich.edu/downloads/oard-dissertation-handbook.pdf>.

### **Before the Defense**

The following steps must be completed prior to the oral defense:

- If defending after the Winter term extended deadline, register for 8.0 credits of CHEMBIO 995 in the Spring/Summer term by the end of April.
- Review and submit any revisions to your dissertation committee at least six months prior to your defense. This can be found on your unofficial transcript or the "View My Committee Information" link under Student Business: Academic Records.
- Register online for the Rackham group pre-defense meeting and submit date, time, and location of oral defense at least 10 working days before the defense.
- Attend scheduled group pre-defense meeting. Bring one complete copy of dissertation to note any formatting corrections.
- Distribute the draft dissertation and abstract (i.e. before the final printing and final reproduction of figures) to the dissertation committee members at least ten working days prior to the oral defense for their suggestions. A committee member who does not receive a copy of the dissertation and an evaluation form at least 10 working days before the defense may ask for a postponement.
- Verify that the dissertation committee has submitted their dissertation evaluations (at least three days before the defense) to Rackham through Wolverine Access.

- Print the Final Oral Examination Report (students will be notified through email) and bring it to the defense to have it signed by the committee.

### **After the Defense**

The following steps must be completed after the completion of the oral defense:

- The Final Oral Examination Report should be returned to Rackham within 48 hours of the exam, but no later than the deadline (<http://www.rackham.umich.edu/students/navigate-degree/doctoral-degree-deadlines>) for the final term of enrollment.
- Submit any final dissertation and abstract revisions to the dissertation committee chair, who will then submit the Certificate of Dissertation Committee Approval to Rackham.
- Apply for graduation on Wolverine Access.
- Complete the online NSF Survey of Earned Doctorates: <https://sed.norc.org/survey>.
- Complete (optional) the Rackham Doctoral Recipients Exit Survey: [https://umich.qualtrics.com/SE/?SID=SV\\_djxDrEF1NQ0cQCN](https://umich.qualtrics.com/SE/?SID=SV_djxDrEF1NQ0cQCN).
- Schedule Post-Defense Meeting with Rackham before doctoral deadline for that term.

### **Degree Deadlines**

Degrees are awarded three times a year, at the end of the fall, winter, and summer terms. The final dissertation deadline for degrees to be awarded at a given commencement is a firm date, and extensions are not permitted. Rackham OARD publishes the deadline dates for the intended final term of enrollment. These dates are available at:

<http://www.rackham.umich.edu/students/navigate-degree/doctoral-degree-deadlines>. By 5:00 PM EST on the published date, the candidate must have completed and submitted all degree requirements, including all format revisions, to Rackham OARD. A candidate who does not meet the final deadline cannot be listed among the degree recipients for that particular term, nor participate in commencement.

Each year OARD publishes deadlines for conferral of degrees in the same term in which a candidate meets all requirements. Students meeting this deadline may participate in commencement exercises, which are held fall and winter terms only. Students completing in spring/summer may participate in a future commencement.

Rackham OARD annually publishes the last day to complete and submit all degree requirements without a new registration. If all requirements are not met by the published deadline, a new registration will be required. Candidates must submit final revisions to Rackham OARD.

Please keep in mind that these deadlines are absolute and you will be required to register in the following term if you do not meet them. The deadlines are published on the Rackham website under *Doctoral Degree* (see section 5.4.10).

## Chronology of the Ph.D. Degree

This section displays the typical academic progression through the Program. Students without prior graduate experience will follow this format. **Students are expected to complete the Program within 5 years.** Students are expected to take a suite of electives that cover the breadth of Chemical Biology

Year One: Fall Term (September - December)

- CHEMBIO 501 001 (macromolecular structure and function; 3 credits)
- CHEMBIO 599 (research rotation; 3 credits)
- PIBS 503 (research responsibilities and ethics, 1 credit)
- Elective course in chemistry, biological chemistry, medicinal chemistry, biophysics or other course in consultation with the Program advisor (3 credits)

Year One: Winter Term (January - April)

- CHEMBIO 502 001 (protein translation, signal transduction and combinatorial methods, 3 credits)
- CHEMBIO 602 001 (critical analysis of the current literature, 1 credit)
- CHEMBIO 599 (research rotation; 3 credits)
- Elective course in chemistry, biological chemistry, medicinal chemistry, biophysics or other course in consultation with the Program advisor (3 credits)

Year One: Spring Term (May - June)

- Select thesis advisor
- Select thesis committee
- Begin thesis research

Year One: Summer Term (July - August)

- Thesis research

Year Two: Fall Term (September - December)

- CHEMBIO 990 (thesis research; 5 credits)
- Elective course in chemistry, biological chemistry, medicinal chemistry, biophysics or other course in consultation with the Program advisor (3 credits)

Year Two: Winter Term (January - April)

- CHEMBIO 990 (thesis research; 5 credits)
- Elective course in chemistry, biological chemistry, medicinal chemistry, biophysics, cell biology, genetics, or other course in consultation with the program advisor (3 credits)
- Doctoral candidacy examination

Years Three – Five

- CHEMBIO 995 (thesis research; 8 credits)
- Students are required to meet once annually with their dissertation committee to review and discuss data and to monitor progress toward the degree
- Teaching assistantships are possible for who wish to gain teaching experience

## Chemical Biology Course Descriptions

CHEMBIO 501 - Chemical Biology I. This course will provide a high-level overview on the structure, function and chemistry of biological macromolecules including proteins, nucleic acids and carbohydrates. Topics include protein and nucleic acid folding, energetics of macromolecular interactions (kinetics and thermodynamics) and mechanistic enzymology. Using specific examples from the current literature, each topic will stress how chemists have used molecular level tools and probes to help understand the specific systems under study. The overarching theme in this course will be that structure and function are intimately linked. Offered in Fall; Section 001 should be selected for PhD students; 3 credits.

CHEMBIO 502 - Chemical Biology II. This course is a continuation of CHEMBIO 501. The basic concepts obtained in CHEMBIO 501 will be applied to and demonstrated in three broad areas of interest to both chemists and biologists. The first topic will discuss combinatorial methods including SELEX and gene shuffling, combinatorial organic synthesis, high throughput screening and chemical genetics. The second topic will focus on signal transduction, emphasizing general concepts (at the molecular level) and how small molecules have been used to probe and modulate signal transduction pathways. The final topic will cover protein translation, stressing mechanistic aspects of protein synthesis and folding in vivo. Offered in Winter; Section 001 should be selected for PhD students; 3 credits.

CHEMBIO 599 - Chemical Biology Research Rotation. This course consists of practical hands-on experience in a faculty member's lab. Students receive training in research methods and techniques necessary for the successful conduct of dissertation research. This course is available to Chemical Biology students only. Offered each term; 2 credits.

CHEMBIO 602 - Critical Analysis in Chemical Biology II. In this course, students will read and dissect papers from the current literature. The specific papers will be selected by the instructor; however, the topics to be emphasized in the papers will loosely parallel and complement the topics covered in CHEMBIO 502. This course is available to Chemical Biology students only. Offered in Winter; Section 001 should be selected for PhD students; 1 credit.

CHEMBIO 990 - Pre-Candidate Dissertation Research. Offered each full term; 1-9 credits.

CHEMBIO 995 - Candidate Dissertation Research. Offered each full term; 1-8 credits.

## **Elective Courses**

The following is a list of potential elective courses; however, this list is meant to serve only as a guide; these courses may or may not be available in a given term. Please consult the time schedule of classes on Wolverine Access (<http://wolverineaccess.umich.edu>) for current availability.

### Bioinformatics

- 527 Introduction to Bioinformatics & Computational Biology
- 528 Advanced Applications of Bioinformatics
- 545 Data Analysis in Molecular Biology
- 551 Proteome Informatics

### Biological Chemistry

- 528 Biology and Chemistry of Enzymes
- 530 Protein-protein and Protein-ligand Interactions by NMR
- 602 Protein Crystallography
- 640 Post-transcriptional Gene Regulation
- 650 Mechanism of Eukaryotic Gene Expression
- 673 Kinetics & Mechanism of Enzymes

### Biophysics

- 520 Biophysical Chemistry I
- 521 Biophysical Chemistry II

### Biostatistics

- 646 Data Analysis in Molecular Biology

### Cancer Biology

- 553 Cancer Biology

### Cell and Developmental Biology

- 530 Cell Biology
- 580 Developmental Biology

### Chemistry

- 507 Inorganic Chemistry
- 515 Organometallic Chemistry
- 540 Organic Principles
- 541 Advanced Organic Chemistry
- 542 Applications of Physical Methods to Organic Chemistry
- 538 Organic Chemistry of Macromolecules
- 543 Organic Mechanisms
- 616 Advanced Inorganic Chemistry
- 673 Kinetics & Mechanism of Enzymes

### Environmental Health Sciences

- 612 Biochemical and Molecular Toxicology

### Epidemiology

- 460 Introduction to Bacterial Pathogenesis
- 560 Mechanisms of Bacterial Pathogenesis

### Human Genetics

- 541 Molecular Genetics

### Medicinal Chemistry

- 532 Bioorganic Principles of Medicinal Chemistry

### Microbiology and Immunology

- 615 Molecular and Cellular Determinants of Viral Pathogenesis I
- 640 Molecular and Cellular Immunology

### Molecular, Cellular, and Developmental Biology

- 608 Biophysical Principles of Microscopy
- 680 Organogenesis of Complex Tissues

### Neuroscience

- 601 Principles of Neuroscience I

### Pathology

- 643 Immunopathologic Mechanism of Disease

### Pharmaceutical Science

- 734 Pharmacogenomics and Drug Discovery

### Pharmacology

- 601 Basic Quantitative Principles of Pharmacology
- 611 Principles of Pharmacology
- 612 Seminar in Antimicrobial and Cancer Pharmacology
- 615 Molecular Neuropharmacology
- 616 Seminar in Cardiovascular Pharmacology
- 619 Structural Basis for Drug Action
- 621 Translational Pharmacology
- 759 Autonomic Nervous System Drugs
- 760 Central Nervous System Drugs

### Physics

- 511 Quantum Theory and Atomic Structure I

## **FINANCIAL INFORMATION**

### **Tuition**

Payment of resident or non-resident tuition fees is determined by residency regulations given in detail on the Registrar's Office website: <http://www.ro.umich.edu/resreg.php>. Student tuition is generally paid by the Program. Students who have advanced to candidacy pay a flat tuition fee without regard to their residency status.

### **Financial Support**

The Chemical Biology Program is committed to providing all graduate students 12 months of financial support for the four to five years of their graduate program tenure. Students must be making satisfactory progress toward the Ph.D. degree to be eligible for support. This support frees the student to concentrate on research and full-time study. Students receive aid through a combination of fellowships, research assistantships (GSRA), and teaching (GSI), that provide tuition, excellent health care benefits and a stipend.

Students may also receive fellowship support in the form of a Research Fellowship awarded directly to the student by a national agency (e.g., NSF), a research foundation, or the University, awarded on a competitive basis.

Research Assistantships (GSRAs). These appointments are provided by a Research Director from grant funds under their supervision. Specific duties and schedules should be discussed with the Research Advisor.

NSF Fellowships. Applications for nationally awarded NSF Fellowships are submitted electronically using the NSF's Fast-Lane system (<https://www.fastlane.nsf.gov/grfp/>). All applicants for NSF or other highly competitive national fellowships should notify the Program Director before preparing their application in order to obtain assistance in making the application as competitive as possible.

Rackham Predoctoral Fellowship. These fellowships are available only to students who have achieved candidacy. Recipients must have been formally admitted to candidacy before the Fellowship is to begin. Selection of nominees for the University-wide competition is made by the Chemical Biology Operating Committee. These fellowships are relatively unrestricted and are awarded on the basis of scholastic record and the student's research achievements. For more information on this fellowship see Funding Resources at the Rackham Graduate School website (<http://www.rackham.umich.edu/>). Each year, candidate students may request that their Research Advisor nominate them for this fellowship. Final nomination decisions are made by the Operating Committee.

Shapiro/Malik Awards. These awards were established by Harold T. Shapiro, former President of the University of Michigan and Vivian Shapiro, former faculty member at the University of Michigan, to assist with interest payments on the unsubsidized educational loans that students are obliged to pay while still in graduate school. Dr. John Malik, a devoted Rackham alumnus in Physics, established an endowment for the same purpose. Both awards are made through a single competition. Students who have unsubsidized educational loans in excess of \$10,000 are given priority. For more information on this fellowship see Funding Resources at the Rackham Graduate School website (<http://www.rackham.umich.edu/>).

Travel Grant. The Rackham Graduate School provides up to \$600 for travel to present a poster or a lecture at domestic professional conferences and meetings (\$700 - \$1,100 for international conferences). Students may only receive one travel grant per fiscal year (July 1 - June 30). Due to strict deadlines and the rapidity with which travel grant funds are depleted, students are encouraged to apply for this funding several months in advance. For more information on this fellowship see Funding Resources at the Rackham Graduate School website (<http://www.rackham.umich.edu/>).

Graduate Student Instructorships (GSIs). Students who are interested in teaching in a given semester may request teaching assignments in the various departments that have undergraduate courses; however, positions are not guaranteed for Chemical Biology students. This appointment is made to qualified Chemical Biology graduate students who have an aptitude and interest in teaching. The conditions of this appointment are governed by the agreement which exists between the Graduate Employees Organization (GEO) and the University. The standard half-time appointment calls for an average of eight contact hours per week and up to 20 hours per week for all teaching-related activities. This time commitment includes, in addition to classroom contact hours, preparation, grading, attendance at staff meetings, office hours and other similar duties. All Graduate Student Instructors who teach chemistry courses are required to attend a Chemistry Department GSI training program, which occurs once per year in August. All international students who wish to teach chemistry courses are required to complete a 3-week acculturation training course given in August (or May for eligible students) in addition to attending the chemistry GSI training. GSIs who teach courses in other departments must meet the specific training requirements of that department. Students will receive the same stipend amount per term regardless of whether or not they decide to teach. Students are only allowed to hold a GSI position in their fifth year with the approval of the Operating Committee.

### **Effort Reporting**

Once a term students who receive a stipend as Graduate Student Research Assistants (GSRA) or Graduate Student Instructors (GSI) will receive notification to complete certification of their effort. Where GSRA support is funded by external sponsors it is important to ensure the effort of the period of appointment has been certified.

The university maintains a system of certifying the percentage of effort to demonstrate to the university's sponsoring partners that the sponsor did in fact receive the level of effort committed through the award process.

Effort certification is completed in Wolverine Access. Students who are unable to complete the process on-line should contact the program for paper certification.

### **Supplementary Income**

Appointment to a half-time assistantship or to an equivalent fellowship is intended to provide sufficient financial support to enable a student to devote full time to his/her graduate program. Consequently, a condition of the appointment is that no outside employment be undertaken other than tutoring. In conditions of unusual financial stress, such as may result from extra dependents or other special circumstances, the student must discuss projected additional employment with his/her Research Advisor and the Program Director.

### **Stipend Payment Schedules**

Fellowship stipends and training grant fellows are paid on a monthly basis approximately two weeks into the month. Stipends for teaching and research appointments are paid in four equal installments per term. Appointment payments are available on the last working day of each month during the appointment term. Wolverine Access (<http://wolverineaccess.umich.edu>) is a useful resource for viewing and updating personal records such as local address, payment schedule and availability status. Students are strongly recommended to select direct deposit as their method of receiving funds, as it is generally the safest and most convenient method. Direct deposit forms may be obtained through the Wolverine Access website.

### **Vacation and Sick Leave**

The Program in Chemical Biology does not have a stipulated time limit for vacation days for graduate students in the program. When joining a research lab either temporarily (rotation period) or permanently, students should ensure that policies on vacation as well as expected work week hours are explained along with any other related lab policies. Regardless of lab policy, it is important to give appropriate notice to your faculty advisor (and GSI supervisor if you are serving as a teaching assistant) for any planned time off, including time around university holidays. Students should ensure that any obligations regarding course work, GSI expectations, or research needs are adequately covered.

Students who are ill should also take time off for recovery and should communicate with supervisors. Students supported on GSRA appointments are provided with sick leave <https://hr.umich.edu/working-u-m/my-employment/academic-human-resources/graduate-student>. If extended sick time is required students should contact the program office about taking a leave of absence. Additionally, Rackham has a Graduate Student Parental Accommodation Policy that can be found here: <http://www.rackham.umich.edu/policies/parental-accommodation-policy>.

### **Loans**

Loan funds administered through the Office of Financial Aid (2500 SAB) are available to meet the needs of any educational expense for students while enrolled in the University. The extent of this financial need must be clearly established by providing a complete statement of the applicant's financial resources and expenses for the academic year. Loans are NOT available for any non-educational expense which is normally financed by a commercial lending institution, nor are they available for the repayment of previously incurred indebtedness. For more information, please see <http://www.finaid.umich.edu/>.

### **Income Tax Liability**

The University, as a withholding agent, is not required to withhold on fellowships or scholarships unless the recipient is a nonresident alien. Graduate Student Instructor (GSI) and Graduate Student Research Assistantship (GSRA) stipends are considered remuneration for services performed and, as such, are subject to withholding and income tax. See information provided through the payroll office at <http://www.finance.umich.edu/finops/payroll/tax>.

## **STAYING INFORMED**

### **Student Handbook**

This Handbook is to be used as a guide to the University, Graduate School and Program rules and regulations that govern the Chemical Biology Doctoral Program. Students should familiarize themselves with requirements of the Program and the Graduate School. Throughout the Handbook, references are made to Graduate School rules and regulations; these may be found in their entirety in Rackham Graduate Student Handbook, which is located at <http://www.rackham.umich.edu/current-students/policies/academic-policies>.

### **E-mail**

Each student is provided with an e-mail account. Messages and information are sent frequently to the student group ([chembiostudents@umich.edu](mailto:chembiostudents@umich.edu)) and to individual students. It is important that students read their UM e-mail on a daily basis.

### **Mailboxes**

For students who have not yet selected a permanent research advisor, all mail will be directed to the program office and placed in a pickup box located in Room 4222 of the Life Sciences Institute. Once a student has been accepted into a permanent laboratory, mail can be forwarded to their laboratory's mailing address.

### **Academic Advisors**

For academic counseling, students may consult with any faculty member on the Operating Committee. Operating Committee members also counsel first year students upon entering the Program. Once the Research Advisor is chosen, questions regarding course work, academic concerns and career objectives and goals should be directed to the Research Advisor. Students are required to meet with their advisor three times per term; however, the members of the Operating Committee are always available for consultation.

### **Administration**

The Program Office is located in 4008 Life Sciences Institute. This office can provide assistance in all matters of the Program, including health insurance, graduate student appointments, graduate records and admissions, recruitment visits, job opportunities, room reservations and seminar postings.

## FACULTY

### Faculty Member

Bailey, Ryan  
Baldrige, Ryan  
Banerjee, Ruma  
Biteen, Julie  
Brooks III, Charles  
Chandrasekaran, Sriram  
Chapman, Matthew  
Cho, Uhn-Soo  
Cianfrocco, Michael  
Cierpicki, Tomasz  
Frank, Aaron  
Garner, Amanda  
Grembecka, Jolanta  
Iniguez-Lluhi, Jorge  
Keane, Sarah  
Kennedy, Robert  
Kerppola, Tom  
Kopelman, Raoul  
Koutmou, Kristin  
Lyssiotis, Costas  
Mapp, Anna (Program Director)  
Marsh, Neil  
Martin, Brent  
Montgomery, John  
Nandakumar, Jayakrishnan  
Narayan, Alison  
Nikolovska-Coleska, Zaneta  
O'Brien, Patrick  
Osawa, Yoichi  
Palfey, Bruce (Associate Director)  
Pecoraro, Vincent  
Penner-Hahn, James  
Ragsdale, Stephen  
Saper, Mark  
Schindler, Corinna  
Scott, Emily  
Sherman, David  
Smith, Janet  
Smrcka, Alan  
Stockbridge, Randy  
Sun, Duxin  
Tall, Gregory  
Trievel, Raymond  
Veatch, Sarah  
Walter, Nils  
Wang, Shaomeng  
Weisman, Lois  
Weiss, Stephen  
Xu, Zhaohui  
Zhang, Yang

### Department

Chemistry  
Biological Chemistry  
Biological Chemistry  
Chemistry  
Chemistry  
Biomedical Engineering  
MCDB  
Biological Chemistry  
Biological Chemistry  
Pathology  
Chemistry; Biophysics  
Medicinal Chemistry  
Pathology  
Pharmacology  
Biophysics; Chemistry  
Chemistry  
Biological Chemistry  
Chemistry  
Chemistry  
Molecular, Integrative Physiology  
Chemistry  
Chemistry  
Chemistry  
Chemistry  
MCDB  
Chemistry  
Pathology  
Biological Chemistry  
Pharmacology  
Biological Chemistry  
Chemistry, Biophysics  
Biophysics; Chemistry  
Biological Chemistry  
Biological Chemistry  
Chemistry  
Medicinal Chemistry  
Medicinal Chemistry  
Biological Chemistry  
Pharmacology  
Biophysics; MCDB  
Pharmaceutical Sciences  
Pharmacology  
Biological Chemistry  
Biophysics  
Chemistry  
Pharmacology; Med Chem  
Cell and Developmental Biology  
Internal Medicine  
Biological Chemistry  
Biological Chemistry

### E-mail

ryancb@umich.edu  
ryanbald@med.umich.edu  
rbanerje@umich.edu  
jsbiteen@umich.edu  
brookscsl@umich.edu  
csriram@umich.edu  
chapmanm@umich.edu  
uhnsoo@umich.edu  
mcianfro@umich.edu  
tomaszc@umich.edu  
afrankz@umich.edu  
algarner@umich.edu  
jolantag@umich.edu  
iniguez@umich.edu  
skeane@umich.edu  
rtkenn@umich.edu  
kerppola@umich.edu  
kopelman@umich.edu  
kkoutmou@umich.edu  
clyssiott@umich.edu  
amapp@umich.edu  
nmarsh@umich.edu  
brentm@umich.edu  
jmontg@umich.edu  
jknanda@umich.edu  
arhardin@umich.edu  
zanetan@med.umich.edu  
pjobrien@umich.edu  
osawa@umich.edu  
brupalf@umich.edu  
vlpec@umich.edu  
jeph@umich.edu  
sragdsal@umich.edu  
saper@umich.edu  
corinnas@umich.edu  
scottee@umich.edu  
davidhs@umich.edu  
janetsmi@umich.edu  
avsmrcka@umich.edu  
stockbr@umich.edu  
duxins@med.umich.edu  
gregtall@umich.edu  
rtrievel@umich.edu  
sveatch@umich.edu  
nwalter@umich.edu  
shaomeng@umich.edu  
lweisman@umich.edu  
sjweiss@umich.edu  
zhaohui@umich.edu  
zhng@umich.edu

### Phone

734.764.1438  
734.763.4008  
734.615.5238  
734.647.1135  
734.647.6682  
734.764.1566  
734.764.7592  
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734.615.2099  
734.615.2060  
734.615.0362  
734.647.2539  
734.764.0030  
734.615.2077  
734.647.1549

## **SUPPORTING FACILITIES**

A large number of services are available across campus to support the research of Chemical Biology students. These include chemical instruments, analytical services, computational facilities and libraries.

The Chemistry Department has a number of technical services, including shops for the fabrication and repair of electronic instruments, glassblowing, and computer support. NMR, mass spectrometry, EPR, elemental analysis, small-molecule X-ray crystallography and other analytical instruments are available for either hands-on use (after training) or as a service. Extensive descriptions can be found at <https://lsa.umich.edu/chem/technical-services.html>

The Medical School maintains a number of core facilities that offer important analytical services. The Biomedical Research Core Facilities include separate facilities devoted to DNA sequencing, flow cytometry, transgenic animals, NMR and protein analyses (mass spectroscopy, sequencing, amino acid analysis, etc.). For details see <https://research.medicine.umich.edu/office-research/biomedical-research-core-facilities>

The Comprehensive Cancer Center maintains an Affymetrix and cDNA Microarray Core Facility. For details, see <https://seqcore.brcf.med.umich.edu/>. The Department of Pharmacology has established a Biomedical Mass Spectrometry Facility, which is described at <https://sites.google.com/a/umich.edu/mass-spectrometry/>.

The Life Sciences Institute (LSI) operates the Center for Structural Biology, which has facilities for the determination of the structures of macromolecules by X-ray diffraction. The LSI also operates the Center for Chemical Genomics, which has facilities for high-throughput screening of small molecule libraries, protein production, automated cloning and protein expression and high-throughput macromolecular crystallization. For details, see <http://www.lsi.umich.edu/centers-and-resources>.

A number of departments and research groups maintain their own computer resources. Beyond these, campus-wide computing facilities and resources are available. A guide to these may be found at <http://www.itcs.umich.edu/>.

The University library system has a very large collection of scientific journals (both print and on-line), books and databases to support research in Chemical biology. The library gateway for access to these resources is <http://www.lib.umich.edu/>.

## **SAFETY and EMERGENCY PRECAUTIONS and PROCEDURES**

It is critical that students follow proper laboratory safety procedures. The research interests of the faculty of the Chemical Biology program are very diverse, making it impossible to create a single set of guidelines that are applicable to all laboratory situations open to students. It is vitally important that students become trained in the safety procedures that are relevant to their lab. All students are required to participate in the Safety Training scheduled prior to Fall term. For more information on general safety information, please see <http://www.ehs.umich.edu/>, the University of Michigan's Environment, Health & Safety organization.

### **Emergency and Safety Regulations/Emergency Telephone Numbers**

In case of an emergency in a campus building, occupants are to use a campus-only phone to dial 911 to provide a description and location of the emergency. The Department of Public Safety (DPS) may also be reached by dialing 3-1131.